

REMARKS

The Applicant respectfully requests further examination and reconsideration in view of the remarks below. Previously, claims 1-32 were pending in the application, of those claims 8, 14-19, and 22-25 are withdrawn. Within the Office Action, claims 1-7, 9-13, 20, 21, and 26-32 are rejected. Accordingly, claims 1-32 are still pending.

Oath and Declaration

Within the Office Action, it is stated that the oath or declaration is defective because:

It does not state that the person making the oath or declaration acknowledges the duty to disclose to the Office all information known to the person to be material to patentability as defined in 37 CFR 1.56.

The Examiner concludes that a new oath or declaration is required.

Under a recent USPTO Notice, a declaration reciting the “material to the examination” language is deemed acceptable, as long as the declaration is filed before June 1, 2008. (“Duty of Disclosure Language Set Forth in Oaths or Declarations Filed in Nonprovisional Patent Applications,” 1327 OG 112, 113 (12 February 2008)). The declaration in this application is acceptable because it recites this language and was filed with the application, on August 8, 2003, well before June 1, 2008.

Claim Rejections Under 35 USC §102

Within the Office Action, claims 1, 4-7, 9-11, and 31-32 stand rejected in view of U.S. Patent Publication 2004/0089008 issued to Tilton et al. (hereafter “Tilton”). The Applicant respectfully traverses this rejection.

Tilton teaches a spray cooling system 10 including a heat exchanging unit 20 and a spray module 50. Within the heat exchanging unit, a reservoir 25 is fluidly connected to an air chamber 29 via air passage 25' for allowing air and other gases within the reservoir 25 to pass upwardly within the coolant through the air passage 25' into the air chamber 29 (Tilton, [0057]). The system also includes a pressure relief valve 42 within an upper portion of the air chamber 29 for allowing periodic releases of the collected air and non-condensable gases from within the air

chamber 29 (Tilton, Figures 5 and 6, [0058]). Tilton specifically teaches that “the heat exchanging unit has an air tolerant design that allows for entry and release of air” (Tilton, [0015]).

Within the Response to Arguments section of the Office Action, the Examiner states that the broadest reasonable interpretation of “sealed cooling system” can include a pressure relief valve. The Examiner’s interpretation of a sealed cooling system can be disputed. However, the claimed limitation additionally specifies that “the fluid and a gas generated from boiling remain sealed within the sealed cooling system” (emphasis added). It is immaterial whether a sealed cooling system can provide access to the ambient environment, such as via a relief valve, because the limitation specifically claims that the gas remain sealed within the sealed cooling system. Therefore, even if a system did include a relief valve, the relief valve could not be used to release gas if the system is to perform the function of gas remaining sealed within the system, for once the gas is released via the pressure relief valve, the gas no longer remains sealed within the system. In direct contrast, Tilton specifically teaches “an air tolerant design” that includes the “release of air.”

The independent claim 1 includes the limitation “wherein the fluid and a gas generated from boiling remain sealed within the sealed cooling system” (emphasis added). As described above, Tilton specifically teaches a pressure relief valve 42 for allowing periodic release of the collected air. Clearly, the released air of Tilton does not remain sealed within the cooling system 10, as claimed. For at least this reason, claim 1 is allowable over Tilton.

Claims 4-7, 9-11, and 31-32 depend from claim 1, which is allowable over Tilton for the reasons presented above. Thus, claims 4-7, 9-11, and 31-32 are allowable as being dependent from an allowable base claim.

Within the Office Action, claims 1, 2, 3, 12, 27-28, and 31-32 stand rejected in view of U.S. Patent Application 6,836,131 issued to Cader et al. (hereafter “Cader”). The Applicant respectfully traverses this rejection.

Cader teaches cooling a heat spreader 617 by using spray heads 615 within a spray chamber 625 to inject fluid onto the heat spreader 617. The coolant delivery pressure of the fluid injected by the spray heads 615 is controlled by a pump 665 (Cader, col. 9, lines 27-29; col. 8 lines 13-14). However, the coolant delivery pressure is not the same as the pressure within the spray chamber 625, and it is the pressure within the spray chamber 625 that determines the boiling point temperature of the fluid.

Cader very explicitly teaches that “the boiling point of the coolant can be controlled by controlling the pressure inside the spray chamber 525 using solenoid 520” (Cader, col. 7, line 66 - col. 8, line 1). There is no discussion within Cader regarding adjusting the pressure of the pumped fluid for the express purpose of adjusting the boiling point of the coolant in the spray chamber. The Examiner attempts to extrapolate the teachings of Cader to arrive at the claimed limitations. Specifically, the Examiner cites col. 9, lines 20-25 of Cader, which teaches “To control the cooling rate, the controller 600 may adjust, for example, the flow rate of the coolant, the temperature of the coolant, or change the pressure in the chamber so as to change the boiling point of the cooling liquid.” The Examiner concludes that an increased pressure in the fluid provided to the spray heads 615, referred to as the coolant delivery pressure, results in an increased pressure in the spray chamber 525, which ultimately results in adjusting the boiling point temperature of the coolant in the spray chamber. However, there is no support for this conclusion within Cader. The Examiner contends that such a conclusion is “explicitly taught - column 9, lines 20-25.” But as can be seen from the actual citation of Cader, it is clearly stated that adjusting the flow rate of the coolant is performed “to control the cooling rate” (emphasis added). Adjusting the flow rate of the coolant is not used to control the pressure within the spray chamber.

The cited col. 9, lines 20-25 of Cader teach three separate method for control the cooling rate. A first is to adjust the flow rate of the coolant. A second is to adjust the temperature of the coolant. A third is to change the pressure in the chamber so as to change the boiling point of the cooling liquid. Cader does not teach that the first method is used to control the third method. Cader teaches that each of the three methods can be used to control the cooling rate. In column 9, lines 25-32, Cader teaches separate techniques for performing the first method and the third method. To perform the first method (adjust the flow rate of the coolant), “a pressure transducer 620 measures the coolant delivery pressure so as to control the pump 665 speed” (Cader, col. 9, lines 27-29). As shown in Figure 6, the pressure transducer 620 is positioned at the inlet side of the spray head 615, in other words external to the spray chamber 625. The “coolant delivery pressure” is the pressure of the fluid provided to the spray head 625, not the pressure of the fluid flowing inside the spray chamber 625. To perform the third method (change the pressure in the chamber to change the boiling point of the cooling liquid), “a pressure transducer 622 measures the pressure inside the spray chamber so as to control a solenoid valve 685 to obtain the appropriate coolant boiling point inside the spray chamber” (Cader, col. 9, lines 29-32). Clearly, changing the cooling delivery pressure (related to the flow rate provided to the spray heads) is not

the same as changing the internal pressure within the spray chamber. Cader explicitly teaches two separate methods for controlling these two separate pressures, Cader even teaching that each method uses separate components, e.g. the pressure transducer 620 and the pump 665 used in method one to control the flow rate of the coolant, and the pressure transducer 622 and the solenoid valve 685 used in method three to control the boiling point of the cooling liquid within the spray chamber. The first method is not used to perform the third method, that is the flow rate is not adjusted to change the boiling point within the spray chamber, as the Examiner contends.

The Examiner contends that within the spray chamber, it is “inherent to changing the pressure - the relationship between the temperature and pressure is an inherent property of a refrigerant and if one changes the pressure the saturation temperature will inherently be adjusted or changed, also expressly taught - column 9, lines 20-25.” But again, there is no support for the conclusion that a pressure change takes place in the spray chamber as a result of increasing the flow rate of the coolant provided to the spray heads.

The independent claim 1 includes the limitation “adjusting a pressure of the flowing fluid to correspondingly adjust a boiling point temperature of the fluid in the at least one heat exchanger” and “the pressure of the flowing fluid is adjusted by dynamically adjusting a fluid flow rate in the at least one heat exchanger.” Cader teaches adjusting the pressure in the spray chamber using a solenoid valve. Cader does not teach adjusting the flow rate to adjust the pressure within the spray chamber. For at least these reasons, claim 1 is allowable over Cader.

Claims 2, 3, 12, 27-28, and 31-32 depend from claim 1, which is allowable over Cader for the reasons presented above. Thus, claims 2, 3, 12, 27-28, and 31-32 are allowable as being dependent from an allowable base claim.

Within the Office Action, claims 1, 20, and 26-32 stand rejected in view of over “Modeling of Two-Phase Microchannel Heat Sinks for VLSI Chips” by Koo et al. (hereafter “Koo”). The Applicant respectfully traverses this rejection.

Within the Office Action, the Examiner contends that the pump of Koo is used to adjust the pressure of the fluid in order to adjust the boiling point of the fluid in the heat exchanger. Page 426 of Koo is cited to support this conclusion. However, page 426 includes only a conclusion, which does not include any discussion related to the pump or adjusting the fluid flow rate, and Figures 8 and 9. Figure 8 shows the dependence of thermal conductance of the microchannel heat sink on the channel width. Clearly, this relationship does not teach adjusting the fluid flow rate. Figure 9 shows the maximum thermal capacity and required hydraulic work

of the microchannel heat sink operating with various liquid flow rates. The relationship shown in figure 9 teaches how the maximum thermal heat capacity and the hydraulic work vary with varying liquid flow rate. Figure 9 does not teach that the liquid flow rate varies as the maximum heat removal capacity and hydraulic work vary, as this is nonsensical. This is further supported on page 426, top of first column, where Koo teaches that “Figure 9 provides an upper bound for the acceptable heat flow at a given mass flow rate.”

The Examiner contends that pumps adjust the pressure of the fluid in order to obtain the data on page 426 (presumed by the Applicant to be the data provided in Figure 9). The Applicant previously argued that the Koo does not dynamically adjust the fluid flow rate in response to a changed property in the heat generating device or the cooling system. In the Response to Arguments section, the Examiner counters that the experimental data provided by Koo “requires changing of the fluid flow rate and pressure and doing so in response to the parameters of interest, e.g. temperature of chip.” However, the experimental data of Koo (Figure 9) does not show that the fluid flow rate is adjusted in response to changed parameters of interest. As discussed above, the parameters of interest (maximum heat removal capacity and hydraulic work) change in response to changed fluid flow rate. The only other data related to fluid flow rate is shown in Figure 5, but this data is for a fixed flow rate, 1.66×10^{-3} g/s. There is no discussion in Koo regarding adjusting the pressure of the pumped fluid in response to changed properties. Further, there is no hint, teaching, or suggestion in Koo to adjust the pressure in the system for any purpose. Again referring to Figure 5, there is a relationship between the input power and the resulting pressure drop for a given, fixed mass flow rate (1.66×10^{-3} g/s). This relationship merely indicates that for a given input power, at a fixed mass flow rate, there results a corresponding pressure drop. Figure 5 clearly indicates that the mass flow rate is not changed. The ‘pressure drop’ of a system is not the same as ‘pressure’ of a fluid within the system. The terms refer to different concepts: the ‘pressure drop’ of a system is the differential pressure that a fluid must overcome to flow through that system; the ‘pressure’ of a fluid within a system is the ratio of the force exerted by the fluid on the inner surface of the system, divided by the inner surface area.

The independent claim 1 includes the limitation “adjusting a pressure of the flowing fluid to correspondingly adjust a boiling point temperature of the fluid in the at least one heat exchanger” and “the pressure of the flowing fluid is adjusted by dynamically adjusting a fluid flow rate in the at least one heat exchanger in response to a changed property of the heat-generating device or the cooling system” (emphasis added). Koo teaches that certain properties

change in response to a change in the fluid flow rate. Koo does not teach adjusting the fluid flow rate in response to changed properties. For at least these reasons, claim 1 is allowable over Koo.

Claims 20 and 26-32 depend from claim 1, which is allowable over Koo for the reasons presented above. Thus, claims 20 and 26-32 are allowable as being dependent from an allowable base claim.

Within the Office Action, claims 1, 20, and 26-32 stand rejected in view of “A Closed-Loop Electroosmotic Microchannel Cooling System for VLSI Circuits” by Jiang et al. (hereafter “Jiang”). The Applicant respectfully traverses this rejection.

Jiang provides test data that supports the existence of pressure drop in a two-phase microchannel heat exchanger, in accordance with the problems detailed in the present application. Jiang makes theoretical predictions and provides experimental data that supports those predictions as to the amount of pressure drop for two-phase flow. However, Jiang does not provide a dynamic solution to the pressure drop problem. The Examiner cites the pressure drop versus power input versus chip temperature graph of Figure 12 (Jiang) as supporting the assertion that Jiang teaches adjusting a pressure of the flowing fluid in response to a changed property of the heat generating device. However, Jiang makes no such conclusion. The ‘pressure drop’ of a system is not the same as the ‘pressure’ of a fluid within the system. The terms refer to different concepts: the ‘pressure drop’ of a system is the differential pressure that a fluid must overcome to flow through that system; the ‘pressure’ of a fluid within a system is the ratio of the force exerted by the fluid on the inner surface of the system, divided by the inner surface area. Jiang specifically teaches measuring a pressure drop, and provides a relationship between pressure drop with varying input power. Jiang does not teach adjusting a pressure of the fluid in response to a changed property.

The independent claim 1 includes the limitation “adjusting a pressure of the flowing fluid to correspondingly adjust a boiling point temperature of the fluid in the at least one heat exchanger” (emphasis added). Jiang teaches the effect of a pressure drop within the system. Jiang does not teach adjusting a pressure of the fluid in response to a changed property. For at least these reasons, claim 1 is allowable over Jiang.

Claims 20 and 26-32 depend from claim 1, which is allowable over Jiang for the reasons presented above. Thus, claims 20 and 26-32 are allowable as being dependent from an allowable base claim.

Claim Rejections Under 35 USC §103

Within the Office Action, claim 13 stands rejected as being unpatentable over the obvious modifications of Cader. Claim 13 is dependent on the independent claim 1. Claim 1 is allowable for at least the reasons presented above. Thus, claim 13 is allowable as being dependent from an allowable base claim.

Within the Office Action, claim 21 stands rejected as being unpatentable over Jiang in view of U.S. Patent Publication 2004/0250994 to Chordia et al. (hereafter "Chordia"). Claim 21 is dependent on the independent claim 1. Claim 1 is allowable for at least the reasons presented above. Thus, claim 21 is allowable as being dependent from an allowable base claim.

For the reasons given above, the Applicant respectfully submits that the pending claims are in a condition for allowance, and allowance at an early date would be appreciated. If the Examiner has any questions or comments, he is encouraged to call the undersigned at (408) 530-9700 so that any outstanding issues can be expeditiously resolved.

Respectfully submitted,
HAVERSTOCK & OWENS LLP

Dated: 8-1-08

By: 

Thomas B. Haverstock
Reg. No.: 32,571

Attorneys for Applicant

CERTIFICATE OF MAILING (37 CFR § 1.8(a))

I hereby certify that this paper (along with any referred to as being attached or enclosed) is being deposited with the U.S. Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to the: Commissioner for Patents, P.O. Box 1450 Alexandria, VA 22313-1450

8/1/08 HAYERSTOCK & OWENS LLP.

Date: 8/1/08

By: 